CLAIMS

1. A method of forming a bottom electrode of a capacitor of a semiconductor device comprising:

forming a first insulation layer pattern having a first etching rate and a first contact hole;

forming a contact plug in the contact hole;

forming a second insulation layer having a second etching rate on the first insulation layer pattern and on the contact plug, wherein the second etching rate is greater than the first etching rate;

forming a second insulation layer pattern having a second contact hole exposing the contact plug by etching the second insulation layer, wherein an etching amount of portions of the first insulation layer pattern near the contact plug is reduced in accordance with an etching rate difference between the second etching rate and the first etching rate;

forming a conductive film continuously on a sidewall and on a bottom face of the second contact hole, wherein the conductive film will become the bottom electrode; and

removing the second insulation layer pattern.

2. The method of claim 1, wherein the first insulation layer pattern comprises a borophosphorsilicate glass (BPSG) film with about 3.5 to 4.5% by weight of boron and about 3.3 to 3.7% by weight of phosphorous, and wherein the second insulation layer pattern comprises a BPSG film with about 2.3 to 2.7% by weight of boron and about 2.25 to 2.65% by weight of phosphorous.

3. The method of claim 1, further comprising:

performing a first cleaning process after forming the first insulation layer pattern; and

performing a second cleaning process after forming the second insulation layer pattern.

4. The method of claim 3, wherein performing the first cleaning process and performing the second cleaning process comprise:

performing a cleaning process chosen from the group consisting of performing a cleaning process using a standard cleaning 1 (SC-1) solution, performing a cleaning process using a hydrogen fluoride (HF) solution, and performing a cleaning process that sequentially uses the hydrogen fluoride (HF) solution and the standard cleaning 1 (SC-1) solution.

5. The method of claim 1, further comprising forming a spacer on a sidewall of the first contact hole.

6. The method of claim 5, wherein forming the spacer on the sidewall of the first contact hole comprises:

forming a film on the sidewall and a bottom face of the first contact hole and on the first insulation layer pattern, wherein the film comprises a film chosen from the group consisting of a silicon nitride film, an oxide film, and a composite film of silicon nitride and oxide; and

etching the film.

7. The method of claim 1, further comprising forming an etch stop layer on the first insulation layer pattern and on the contact plug.

8. The method of claim 7, wherein forming the etch stop layer on the first insulation layer pattern and on the contact plug comprises:

forming the etch stop layer with a film chosen from the group consisting of a silicon nitride film, an oxide film, and a composite film that includes silicon nitride and oxide.

9. The method of claim 8, further comprising removing the etch stop layer.

10. The method of claim 9, wherein removing the etch stop layer comprises:

removing the etch stop layer with a wet etching process using a phosphoric acid solution if the etch stop layer comprises the silicon nitride film;

removing the etch stop layer with a wet etching process using a LAL solution if the etch stop layer comprises the oxide film; and

removing the etch stop layer with a wet etching process sequentially using the phosphoric acid solution and the LAL solution if the etch stop layer comprises the composite film.

11. The method of claim 1, further comprising:

forming a protection layer on a portion of the first insulation pattern exposed by the second contact hole and on a sidewall of the second contact hole.

12. The method of claim 11, wherein the protection layer comprises a film chosen from the group consisting of a silicon nitride film, an aluminum oxide film, and a composite film including a silicon nitride film and an aluminum oxide film.

13. The method of claim 12, further comprising:

partially removing the protection layer so that a portion of the protection layer remains near the contact plug.

14. The method of claim 13, wherein partially removing the protection layer comprises:

partially removing the protection layer with a wet etching process using a phosphoric acid solution if the protection layer comprises the silicon nitride film;

partially removing the protection layer with a wet etching process using a LAL solution if the protection layer comprises the aluminum oxide film; and

partially removing the protection layer with a wet etching process sequentially using the phosphoric acid solution and the LAL solution if the protection layer comprises the composite film.

15. The method of claim 1, wherein forming the second insulation layer pattern comprises forming the second insulation layer pattern using a process chosen from the group consisting of a dry etching process and a wet etching process.

16. The method of claim 2, wherein the second insulation layer pattern is removed with a wet etching process using a LAL solution.

17. The method of claim 1, further comprising:

forming a third insulation layer having a third etching rate on the second insulation layer pattern, wherein the third etching rate is smaller than the second etching rate; and

forming a third insulation layer pattern having a third contact hole exposing a portion of the second insulation layer pattern where the second contact hole is formed by etching the third insulation layer, wherein a critical dimension of the third contact hole is smaller than a critical dimension of the second contact hole in accordance with an etching rate difference between the third etching rate and the second etching rate.

18. The method of claim 17, wherein the third insulation layer comprises tetraethylorthosilicate (TEOS).

19. The method of claim 17, wherein forming the third insulation layer pattern comprises forming the third insulation layer pattern using a process chosen from the group consisting of a dry etching process and a wet etching process.

20. The method of claim 18, further comprising:

removing the third insulation layer pattern.

21. The method of claim 20, wherein removing the third insulation layer pattern comprises:

removing the third insulation layer pattern with a wet etching process using a LAL solution.

22. A method of forming a bottom electrode of a capacitor of a semiconductor device comprising:

forming a first insulation layer pattern having a first contact hole;

forming a contact plug in the first contact hole;

forming a second insulation layer pattern on the first insulation layer pattern, the second insulation layer pattern having a second contact hole exposing the contact plug and a portion of the first insulation layer pattern;

forming a protection layer on a sidewall of the second contact hole and on the portion of the first insulation layer pattern;

forming a conductive film for the bottom electrode continuously on the protection layer and on the contact plug;

removing the second insulation layer pattern; and

partially removing the protection layer so that a portion of the protection layer remains near the contact plug.

23. The method of claim 22, wherein the first insulation layer pattern has a first etching rate that is smaller than a second etching rate of the second insulation layer pattern.

24. The method of claim 23, wherein the first insulation layer pattern comprises a BPSG film including about 3.5 to 4.5% by weight of boron and about 3.3 to 3.7% by weight of phosphorous, and the second insulation layer pattern comprises a BPSG film including about 2.3 to 2.7% by weight of boron and about 2.25 to 2.65% by weight of phosphorous.

25. The method of claim 22, further comprising:

performing a first cleaning process after forming the first insulation layer pattern; and

performing a second cleaning process after forming the second insulation layer pattern.

26. The method of claim 25, wherein performing a first cleaning process and performing a second cleaning process comprise:

performing a process chosen from the group consisting of a cleaning process using a standard cleaning 1 (SC-1) solution, a cleaning process using a hydrogen fluoride (HF) solution, or a cleaning process sequentially using the standard cleaning 1 (SC-1) solution and the hydrogen fluoride (HF) solution.

27. The method of claim 22, further comprising:

forming a spacer on a sidewall of the first contact hole.

28. The method of claim 27, wherein forming the spacer on the sidewall of the first contact hole comprises:

forming a spacer on the sidewall and a bottom face of the first contact hole and on the first insulation layer pattern, wherein the spacer comprises a film chosen from the group consisting of a silicon nitride film, an oxide film, and a composite film that includes a silicon nitride film and an oxide film; and

etching the spacer.

29. The method of claim 22, further comprising:

forming an etch stop layer on the first insulation layer pattern and on the contact plug.

30. The method of claim 29, wherein forming the etch stop layer comprises:

forming a film chosen from the group consisting of a silicon nitride film, an oxide film, and a composite film that includes a silicon nitride film and an oxide film.

31. The method of claim 30, further comprising:

removing the etch stop layer.

32. The method of claim 31, wherein removing the etch stop layer comprises:

removing the etch stop layer with a wet etching process that uses a phosphoric acid solution if the etch stop layer comprises the silicon nitride film;

removing the etch stop layer with a wet etching process that uses a LAL solution if the etch stop layer comprises the oxide film; and

removing the etch stop layer with a wet etching process that sequentially uses the phosphoric acid solution and the LAL solution if the etch stop layer comprises the composite film.

33. The method of claim 22, wherein forming a protection layer comprises:

forming a film chosen from the group consisting of a silicon nitride film, an aluminum oxide film, and a composite film that includes a silicon nitride film and an aluminum oxide film.

34. The method of claim 33, wherein partially removing the protection layer comprises:

partially removing the protection layer with a wet etching process that uses a phosphoric acid solution if the protection layer comprises the silicon nitride film;

partially removing the protection layer with a wet etching process that uses a LAL solution when the protection layer comprises the aluminum oxide film;

partially removing the protection layer with a wet etching process that sequentially uses the phosphoric acid solution and the LAL solution if the protection layer comprises the composite film.

35. The method of claim 22, wherein forming a second insulation layer pattern comprises forming the second insulation layer pattern with a process chosen from the group consisting of a dry etching process and a wet etching process.

36. The method of claim 24, wherein removing the second insulation layer pattern comprises removing the second insulation layer pattern with a wet etching process that uses a LAL solution.

37. The method of claim 23, further comprising:

forming a third insulation layer with a third etching rate on the second insulation layer pattern, wherein the third etching rate is less than the second etching rate; and

forming a third insulation layer pattern having a third contact hole exposing a portion of the second insulation layer pattern where the second contact hole is formed by etching the third insulation layer, wherein a critical dimension of the third contact hole is smaller than a critical dimension of the second contact hole in accordance with an etching rate difference between the third etching rate and the second etching rate.

38. The method of claim 37, wherein forming a third insulation layer comprises forming a TEOS layer.

39. The method of claim 37, wherein forming a third insulation layer pattern comprises using a process chosen from the group consisting of a dry etching process and a wet etching process.

40. The method of claim 38, further comprising:

removing the third insulation layer pattern.

41. The method of claim 40, wherein removing the third insulation layer pattern comprises:

removing the third insulation layer pattern with a wet etching process that uses a LAL solution.

42. A bottom electrode of a capacitor of a semiconductor device comprising:

a contact plug formed on a substrate;

a node formed on the contact plug; and

a protection layer pattern formed near the contact plug, wherein the contact plug is electrically connected to the node, and the protection layer pattern prevents an electrical connection between the contact plug and an adjacent contact plug.

43. The bottom electrode of claim 42, wherein the protection layer pattern comprises a film chosen from the group consisting of a silicon nitride film, an aluminum oxide film, and a composite film that includes a silicon nitride film and an aluminum oxide film.

44. The bottom electrode of claim 42, wherein the node has a cylindrical shape.

45. The bottom electrode of claim 42, wherein the node comprises an upper node and a lower node, and wherein a critical dimension of the lower node is larger than a critical dimension of the upper node.